

anated from landslides in the Santa Susanna Mountains caused by the Northridge earthquake in January 1994. In all, 170 cases were reported in a seven-week period following the earthquake. This outbreak is unusual in that Ventura County is not typically considered a hyperendemic area of coccidioidomycosis, although the Santa Susanna Mountains are part of the range that demarcates the southern range of the San Joaquin Valley. The climatic and soil factors that led to the general outbreak of coccidioidomycosis centered in Kern County also may have led to a similar bloom of *C immitis* on the southern edge of the Tehachapi range.

The third outbreak, which is intimately intertwined with the first, has occurred among patients with human immunodeficiency virus (HIV) infection in California. Coccidioidomycosis in the presence of HIV infection became a defining illness for the acquired immunodeficiency syndrome (AIDS) in the Centers for Disease Control's 1987 revision of the AIDS case definition. From 1987 to August 31, 1995, 317 cases of coccidioidomycosis had been reported among AIDS patients in California; in 158 (50%) of these, coccidioidomycosis was the first AIDS-defining opportunistic infection. Although accounting for only 0.3% of all AIDS-defining illnesses in California during this period, coccidioidomycosis accounted for 3.5% of new AIDS diagnoses in Kern County, 2.9% in Tulare County, and 2.2% in San Luis Obispo County. Interestingly, AIDS patients who had coccidioidomycosis as an AIDS-defining diagnosis were significantly more likely to be injection-drug users (18%) than those who had other AIDS-defining diagnoses (9%;  $P = .006$ ).

The prevention of coccidioidomycosis is difficult, and efforts in the past have focused on preventing infection among short-term residents, such as military trainees, in endemic areas. In work with the Army Air Corps in World War II, one investigator focused on dust control—limiting construction during peak months, planting lawns, and paving roads and airstrips—to decrease the risk of infection. In one study, the attack rate among susceptible persons was 0.65% among recruits at Minter Field in Kern County, where these measures were employed, compared with 10% among German prisoners of war in a detention facility adjacent to Minter Field where these measures were not employed during the same 70-day period. Although other types of environmental controls have been discussed, such as the widespread application of fungicides or the use of respirators for construction workers, the ubiquity of the organism in its natural environment makes these measures and our traditional strategy of dust control less than adequate for controlling long-term exposure to the disease.

If we are unable to control long-term exposure to *C immitis*, the only remaining reasonable strategy to pursue is immunization. Attempts have been made to develop a vaccine for coccidioidomycosis, but these have been unsuccessful. Nevertheless, with the advancements in our understanding of the biology of the immune response to *C immitis* and with the general advancement in the techniques of molecular biology, coccidioidomycosis would

seem a logical target for vaccine development. Unfortunately, given a commercial market limited to endemic areas, it is unlikely that vaccine manufacturers would embrace development.

Coccidioidomycosis has long been and continues to be a preventive medicine problem for the armed forces, however, and the Army, Navy, Marines, and Air Force still deploy large numbers of personnel to endemic areas. Perhaps the time is right for a new public-private partnership to be forged among commercial biotechnology firms, the Department of Defense, and the Public Health Service to exploit the new molecular biology and to focus an intensive research effort on a vaccine to prevent this important infection.

GEORGE W. RUTHERFORD, MD  
MARK F. BARRETT  
Berkeley, California

#### REFERENCES

- Centers for Disease Control and Prevention (CDC): Coccidioidomycosis following the Northridge earthquake—California, 1994. *MMWR Morbid Mortal Wkly Rep* 1994; 43:190–192
- CDC: Update: Coccidioidomycosis—California, 1991–1993. *MMWR Morbid Mortal Wkly Rep* 1994; 43:421–423
- Olson PE, Bone WD, LaBarre RC, et al: Coccidioidomycosis in California: Regional outbreak, global diagnostic challenge. *Milit Med* 1995; 160:304–308
- Rush WL, Dolley DP, Blatt SP, Drehner DM: Coccidioidomycosis: A persistent threat to deployed populations. *Aviat Space Environ Med* 1993; 64:653–657
- Stevens DA: Current concepts: Coccidioidomycosis. *N Engl J Med* 1995; 332:1077–1082

## Occupational Lead Exposure and Management

MANY ADVERSE HEALTH effects of lead exposure are recognized, including cardiovascular, reproductive, neurotoxic, metabolic, and hematologic abnormalities. As researchers have developed more sensitive indicators of outcomes, no clear threshold for lead's toxic effects has been found. To establish a practical objective for controlling the problem of occupational lead exposure, *Healthy People 2000* proposes the elimination of "exposures which result in workers having blood lead concentrations greater than 25  $\mu\text{g}$  per dl [1.21  $\mu\text{mol}$  per liter] of whole blood." The accomplishment of this goal is supported by two national lead standards established by the Occupational Health and Safety Administration (OSHA)—one for general industry (1979) and a newer one for construction work (1993). These standards require workplace monitoring by employers and establish medical monitoring for exposed employees. Public health agencies, however, do not routinely receive information to assess the actual exposures; instead, they do surveillance primarily through the reporting of blood levels by laboratories under mandatory state lead surveillance programs.

There are now 23 state lead registries that report blood levels to the Adult Blood Lead Epidemiology and Surveillance Program at the Centers for Disease Control and Prevention. Data from 1994 indicate that there are 12,137

adults with blood lead levels of 1.21  $\mu\text{mol}$  per liter (25  $\mu\text{g}$  per dl) or higher, and that extrapolates to about 19,000 cases nationwide. Research has shown that about 95% of cases of adult lead intoxication are occupational in origin. Given the recent implementation of the construction industry standard, data from the Occupational Lead Poisoning Prevention Program (OLPPP) at the California Department of Health Services begin to define the contribution of construction work to the overall lead problem. In 1993, the California OLPPP received reports on 1,163 workers with elevated lead levels ( $\geq 1.21$   $\mu\text{mol}$  per liter), with 161 (11%) from the construction industry. By comparison, 32% of reports are from storage battery manufacturers, 13% from smelting industries, and 7% from automotive radiator repair shops. The 1994 data showed 1,332 cases of elevated levels, with 106 (8%) from construction industries.

These surveillance data indicate that occupational lead exposure and poisoning remain a substantial problem as we approach the millennium. This point is underscored by the recognition of widespread noncompliance with the OSHA standard's requirements for blood testing of lead workers. For example, only 10 of 405 wrecking and demolition companies and 43 of 4,768 painting contractors in California reported blood lead levels in 1994.

Although there is good reason to think that the nation will not meet the *Healthy People 2000* objective to eliminate notable lead exposures, overall lead levels appear to be falling in the United States. Results from the Third National Health and Nutrition Examination Survey (NHANES III) (1988 through 1991) showed a geometric mean blood lead level for all ages to be 0.14  $\mu\text{mol}$  per liter (2.8  $\mu\text{g}$  per dl), which is down from 0.62  $\mu\text{mol}$  per liter (12.8  $\mu\text{g}$  per dl) in the NHANES II (1976 through 1980.) The declines were relatively consistent across all age categories. Nevertheless, in the NHANES III, 0.5% of adults aged 20 to 49 years had blood lead levels of 1.21  $\mu\text{mol}$  per liter or higher, as did 0.3% of adults aged 50 to 69 years. Most of these adult elevations can be attributed to occupational exposure.

Various methods have been proposed to improve the control of occupational lead poisoning. Efforts to develop lead registries in states that do not have them and to standardize the practices among registries would allow for better surveillance and, an important element, case recognition. More personnel available to investigate reported cases would, in all likelihood, lead to the recognition of cases among co-workers and improved exposure control. Placing broader requirements on employers for blood lead medical surveillance has also been advocated.

A different approach to the problem is true exposure surveillance (or hazard surveillance). In this method, a list of lead-using industries would be established for the purpose of tracking the uses of this toxic agent and better determining the groups at risk. A pilot project of this type has been implemented with the automotive radiator industry in Los Angeles and San Bernardino counties, California. As a result of efforts to systematically identify the companies, to work with them to develop on-site lead

poisoning prevention programs, and to maintain regular contact, the percentage of employees in medical surveillance went from 9% to 95%.

Apart from enhanced medical and hazard surveillance, another way to advance towards the *Healthy People 2000* goal is to eliminate or reduce the uses of lead. Product substitution or elimination is a key principle in occupational and environmental health. It has been used successfully in US lead policy by mandating greatly reduced use in gasoline and paint, and this can be credited for most of the decreases in lead levels found in the NHANES III. Proponents of this approach have advocated high excise fees on lead use in industry and increased research into substitute materials. California has established a fee on some of its lead products industries, but the fee is set primarily to finance public health efforts, not as a regulatory deterrent to lead use.

Practitioners in different settings are confronting the issue of how to provide the best medical care for an adult with an elevated lead level. Although many such cases are identified through surveillance by occupational medicine practitioners, a substantial number are discovered by other primary care professionals through good history taking, patient concerns, or symptoms. Confusion has occurred over the appropriate treatment protocol for adults, with some adults inappropriately receiving chelation therapy under guidelines intended for children. This misconception has perhaps been aggravated by the fact that some laboratories have sent out recommendations for chelation based on blood levels without considering the age of the patient.

As a result of inappropriate treatment and the use of chelating agents, management guidelines have been developed and are available from the California OLPPP—(510) 540-3448. The treatment of adults with chelating agents is based primarily on symptoms and is generally not indicated without symptoms. This is in contrast to child lead poisoning in which chelation is recommended in children with blood lead levels of 2.17  $\mu\text{mol}$  per liter (45  $\mu\text{g}$  per dl) or higher. Workers with blood lead levels between 0.48 and 1.16  $\mu\text{mol}$  per liter (10 and 24  $\mu\text{g}$  per dl) should have exposures identified and minimized. For adults with levels of 1.21 to 2.36  $\mu\text{mol}$  per liter (25 to 49  $\mu\text{g}$  per dl), there should be regular monitoring of blood lead and zinc protoporphyrin levels and the removal from exposure if symptomatic. Workers with blood lead levels above 2.40  $\mu\text{mol}$  per liter (50  $\mu\text{g}$  per dl) require removal from the workplace lead exposure in accordance with the OSHA standards, a complete medical evaluation, and ongoing monitoring with blood lead and zinc protoporphyrin levels. Practitioners should refer to appropriate federal or state lead standards for complete requirements of regulatory programs.

JAMES P. SEWARD MD, MPP  
Berkeley, California

#### REFERENCES

- Brody DJ, Pirkle JL, Kramer RA, et al: Blood lead levels in the US population—Phase I of the Third National Health and Nutrition Examination Survey

(NHANES III, 1988 to 1991). JAMA 1994; 272:277–283

Centers for Disease Control and Prevention: Adult blood lead epidemiology and surveillance—United States, third quarter, 1995. MMWR Morbid Mortal Wkly Rep 1996; 45:170–171

Healthy People 2000—National Health Promotion and Disease Prevention Objectives, publication No. (PHS) 91-50212. US Dept of Health and Human Services, Office of Disease Prevention and Health Promotion, 1991

Kaufman JD, Burt J, Silverstein B: Occupational lead poisoning: Can it be eliminated? Am J Ind Med 1994; 26:703–712

Occupational Lead Poisoning Prevention Program (OLPPP): Lead in the Workplace. Berkeley, Calif, Dept of Health Services, 1995

OLPPP/HESIS Medical Guidelines: The Lead-Exposed Worker. Berkeley, Calif, Dept of Health Services, 1995

## Human Babesiosis and Ehrlichioses—Emerging Tick-Borne Diseases

LYME DISEASE was the emerging tick-borne infectious disease on the West Coast in the 1980s. Now, however, the diseases babesiosis and ehrlichiosis must also be considered in patients who are febrile and have a history of tick exposure.

Babesiosis is a malaria-like illness caused by a species of *Babesia*, an intraerythrocytic parasite. Fever, chills, headache, and hemolytic anemia are common, and diagnosis is made by finding ring-shaped intraerythrocytic parasites on blood smears. *Babesia microti* has been the primary strain causing human disease in the northeastern United States. Since 1991, however, five patients in the West—4 in California and 1 in Washington State—have been diagnosed with a *Babesia*-like organism designated WA1 (named for the first isolate in Washington State). Serum specimens from four of these five patients reacted to WA1 but not to *B. microti*. All the California patients had a previous splenectomy, and one died of fulminant babesiosis, but the Washington patient was normosplenic and immunocompetent. From limited serosurveys, subclinical infection also occurs. The treatment of choice for disease with this new *Babesia*-like parasite has not yet been established, but patients have recovered after treatment with quinine and clindamycin. In the northeastern United States, *B. microti* is transmitted by *Ixodes scapularis* ticks; the vector(s) for WA1 have not yet been identified.

Human ehrlichiosis is caused by two different species of *Ehrlichia*, which are obligate intracellular bacteria similar to rickettsiae. Human monocytic ehrlichiosis is caused by *Ehrlichia chaffeensis*, which invades mononuclear phagocytes, and human granulocytic ehrlichiosis is caused by a newly identified *Ehrlichia* species that is closely related to *Ehrlichia equi* and invades neutrophils. Exposure to *Ehrlichia* species may result in anywhere from asymptomatic infection to severe disease, the latter occurring particularly in older persons. Presenting signs and symptoms of ehrlichiosis due to either species are generally nonspecific: fever, chills, malaise, headache, muscle aches, and nausea. Blood tests commonly reveal elevated liver enzyme levels, leukopenia, and thrombocytopenia.

Since human monocytic ehrlichiosis was first described in 1987, more than 300 cases have been diagnosed, mostly in southern states. Human granulocytic

ehrlichiosis, on the other hand, was first reported in 1994 in patients from Minnesota and Wisconsin and has since been identified in several northeastern states. In northern California, both human monocytic and granulocytic ehrlichioses are now diagnosed: in 1994 an elderly man was admitted to a hospital with a severe febrile illness due to human monocytic ehrlichiosis who had a greater than fourfold rise in levels of antibody to *E. chaffeensis*. In 1995 human granulocytic ehrlichiosis was diagnosed by blood smear, polymerase chain reaction, and subsequently serologic tests in two adults, both of whom recovered with the administration of doxycycline. Both types of ehrlichioses can be treated effectively with doxycycline or tetracycline. The three California patients had not traveled out of their county in the three months before their illnesses began; two recalled removing a tick from themselves three weeks before their symptoms began. Whereas tick vectors for *E. chaffeensis* in the southern states include *Amblyoma americanum* and *Dermacentor variabilis* and vectors for the human granulocytic ehrlichiosis agent in the Northeast include *I. scapularis*, the tick vectors for *Ehrlichia* species in California have not yet been established.

There are measures the public can take to reduce the risk of tick-borne diseases: when spending time outdoors in tick-infested areas, wear long-sleeved shirts, long pants, and socks, tucking shirts into pants and pants into socks; wear light-colored clothing to facilitate seeing ticks; use tick-repellent products; check self and children carefully for ticks; and remove any attached tick by grasping it with tweezers as close as possible to the point of attachment and pulling gently away from the skin. On the West Coast, prophylactic treatment of persons bitten by ticks is not recommended currently.

DUC J. VUGIA, MD, MPH  
VICKI L. KRAMER, PhD  
Berkeley, California

## REFERENCES

- Bakken JS, Krueth J, Wilson-Nordskog C, Tilden RL, Asanovich K, Dumler JS: Clinical and laboratory characteristics of human granulocytic ehrlichiosis. JAMA 1996; 275:199–205
- Dumler JS, Bakken JS: Ehrlichial diseases of humans: Emerging tick-borne infections. Clin Infect Dis 1995; 20:1102–1110
- Persing DH, Herwaldt BL, Glaser C, et al: Infection with a *babesia*-like organism in northern California. N Engl J Med 1995; 332:298–303
- Quick RE, Herwaldt BL, Thomford JW, et al: Babesiosis in Washington State: A new species of *Babesia*? Ann Intern Med 1993; 119:284–290
- Vugia DJ, Holmberg E, Steffe EM, Ascher MS, Gallo D: A human case of monocytic ehrlichiosis with adult respiratory distress syndrome in northern California. West J Med 1996; 164:525–528

## Directly Observed Therapy for Tuberculosis

FROM 1985 TO 1992, there was an increase in the number of active tuberculosis (TB) cases, from 22,000 to 26,673, reversing a downward trend of three decades. This resurgence in TB in the United States was due to multiple fac-